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Eastern Dwarf Mistletoe on Black Spruce

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Eastern dwarf mistletoe, *Arceuthobium pusillum* Peck, is a perennial, obligate, parasitic seed plant belonging to the family *Viscaceae*. It is mainly found on black spruce, *Picea mariana* (Mill.) B.S.P., and is the major cause of death in the black spruce type. *A. pusillum* is also found on white spruce, *Picea glauca* (Moench) Voss and occasionally on red spruce, *P. rubens* Sarg. and eastern larch, *Larix laricina* (Du Roi) K. Koch. Rare hosts include blue spruce, *P. pungens* Engelm.; jack pine, *Pinus banksiana* Lamb.; red pine, *P. resinosa* Ait.; and eastern white pine, *P. strobus*, L.

In the United States, eastern dwarf mistletoe is found on black spruce in the northern parts of Minnesota, Wisconsin, and Michigan. In 1976, 15 percent of the black spruce stands on National Forest lands in the above-named states were infected. Eastern dwarf mistletoe is also found in northeastern Pennsylvania, extreme northwestern New Jersey, New York, and the New England States. White spruce is often heavily attacked along the Maine coast. In Canada, this mistletoe occurs from eastern Saskatchewan to southern Manitoba, southern Ontario, Quebec, the Maritime Provinces, and Newfoundland.

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Black spruce is a valuable species, used in the manufacture of high-quality paper. On many lowland sites black spruce is the only commercially important tree species. Therefore, it is important to protect black spruce from dwarf mistletoe infection.

Description

The eastern dwarf mistletoe plant, like all members of the genus *Arceuthobium*, has an endophytic rootlike system that absorbs nutrients from within the host tissues and a reproductive system of aerial shoots that rise from the host branch.

Small (1 to 3 cm or 0.4 to 1.2 in) green to brown aerial shoots with scalelike leaves are unbranched, perennial, and dioecious (fig. 1). Although the shoots contain chlorophyll, the parasite obtains most, if not all, of its carbohydrates from the host tree. Eastern dwarf mistletoe commonly results in systemic infections in which the endophytic system grows with the infected branch allowing mistletoe shoots to occur along the entire branch. Male shoots die soon after flowering and female shoots die after their seeds have been discharged. Basal cups remain on the portions of branches where aerial shoots have died and fallen off (fig. 2).

The most apparent symptom of mistletoe-infected black spruce is the stimulated growth and phototropic response of branches at the point of infection (cover photo).

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Figure 1.—*Aerial mistletoe shoots on black spruce.*

The bushy, compact masses of branches and twigs that result are called "witches' brooms." These persist for as long as the host remains alive and may grow to be 1 to 3 m (3 to 9.8 ft) in diameter. Heavily infected trees with older infections have severely malformed branches and spike tops. Presence of aerial shoots or basal cups are the most positive sign of mistletoe infection and distinguish witches' brooms from those of the spruce broom rust caused by *Chrysomyxa arctostaphyli* Diet. A less conspicuous symptom is the swelling of the branch at the point of a young infection.

Damage to black spruce due to dwarf mistletoe infection includes reduced growth, wood quality, and seed production. Dwarf mistletoe is the major cause of reduced stocking levels in the

black spruce type. In heavily affected areas stocking levels are so low that a commercial harvest is impossible. Dwarf mistletoe kills young saplings and eventually kills older trees as a result of reduced tree vigor.

Weakened trees are more susceptible to drought and attack by insects and fungi. Black spruce growing on organic sites are not windfirm. In areas where the canopy has been opened up by mortality caused by dwarf mistletoe large losses due to windthrow can occur.

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Figure 2.—*Basal cups on mistletoe-infected branch.*

Life Cycle

The life cycle of *A. pusillum*, from infection of the host to the first crop of fruit, requires at least 4 years (fig. 3). Each fruit contains a single viscous-coated seed that is explosively expelled from the fruit when it matures in early or late September. This is the most common method of seed dispersal and can scatter seed up to 15.2 m (50 ft). Birds and squirrels can disperse seeds longer distances, but infection by this method occurs infrequently. Dwarf mistletoe seeds stick to the feathers of birds or fur of squirrels as they forage in and around infected trees and they inadvertently carry the seeds to healthy trees, thus beginning new infections.

The average annual outward spread of the parasite from an infection center to surrounding healthy trees is 0.5 to 3 m (1.6 to 9.8 ft). Spread is faster in uneven-aged stands than in even-aged stands because infected overstory trees disperse seeds to understory trees over a larger radius.

The seeds readily adhere to objects they strike, and needles are particularly effective in intercepting them. Seeds adhere tightly to the needles until rain moistens the viscous coating. Then the seeds slide down the needles and some of the seeds become attached to the twigs as their viscous coating dries. Germination of the seed takes place the next

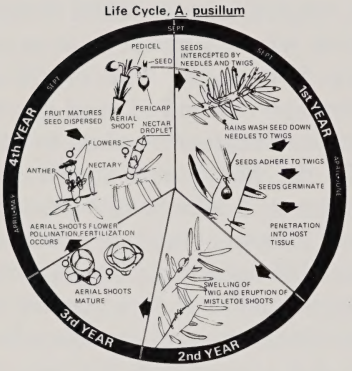

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Figure 3.—*Life cycle of* A. pusillum.

spring. The radicle forms a holdfast, which is a disc-like swelling, when it contacts an obstruction on the host branch such as the base of a needle. A penetrating wedge of mistletoe tissue develops from the holdfast but generally it successfully penetrates only host tissue less than 5 years old. Once established a period of at least 4 years is required for shoot formation and subsequent flowering. Flowers appear in April or early May (figs. 4 and 5) and are predominantly insect-pollinated. After pollination, fruit develops and matures and expels seeds in the fall (fig. 6).

Control

Eastern dwarf mistletoe is endemic and unless eradicated it will persist in a stand for as long as the host is alive. Wildfire, once a natural control, has almost been eliminated from spruce stands due to effective fire suppression methods. Thus, unless a suitable substitute control measure is taken, areas of black spruce infected with dwarf mistletoe will increase. Many logging practices leave infected trees that contribute to the increase in damage by dwarf mistletoe, because these logging practices actually create conditions favoring the parasite.

Successful control of eastern dwarf mistletoe is possible for several reasons: (1) dwarf mistletoe is an obligate parasite confined to the aboveground portions of a specific host; (2) pockets of

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Figure 4.—*Mature male flowers.*

mistletoe-infected trees can often be readily detected from the air; (3) seed production and dispersal are limited by many factors; and (4) many years are required before infection reaches critical levels. Control is easier in even-aged stands if they are to be harvested by clearcutting.

Mistletoe control strategies will vary depending upon stand structure, site index, infection level, and economics. In general, however, as the value of black spruce increases, use of control measures as an integral part of silvicultural management will avoid large future losses and expenditures.

Ideally, control programs should have two objectives: (1) to protect future stands by incorporating control methods in present harvesting techniques; and (2) to reduce new infections in regeneration by eliminating infected trees from stands cut within the last 10 years. The following general guidelines can significantly reduce the impact of this disease.

1. Reproduce and maintain dense stands because dwarf mistletoe spreads more slowly and causes less damage in dense stands than in open stands. Brooms within dense stands are usually smaller and less vigorous

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Figure 5.—*Three-parted male (left) and two-parted female (right) flowers prior to opening.*

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Figure 6.—*Mature fruit prior to seed dispersal in September.*

and the mistletoe produces fewer seeds. Light is an important factor in the development of mistletoe. In addition, in dense stands, surrounding trees limit seed dispersal and may kill infected trees or brooms by shading and overtopping them.

2. Clearcut the infected area(s) plus a surrounding isolation strip that appears to be entirely uninfected to remove latent infections that cannot be seen, when harvesting mature stands where witches' brooms are readily noticeable. Make this strip a minimum of 20 m wide (66 ft) but preferably 40 m wide. All infected trees, including advance reproduction and especially any tall unmerchantable stems, must be cut or killed to prevent new reproduction from becoming infected. Where possible, broadcast burn slash on large clearcut areas because it is an effective and economical way to kill all residual trees and prepares the site for good black spruce reproduction.

3. Examine stands that have been cut within the last 10 years for the presence of infected residual trees. These trees should be cut or killed to protect the regeneration from infection. The best sites should be given first priority for this type of control.

4. Treat small pockets of mistletoe-infected trees that may develop in immature stands from seed carried in by animals. If not treated, they gradually enlarge and are a source of seed for starting new pockets, which can eventually merge with older ones. As in mature stands, all trees should be cut in both the infection pocket and in a 20 to 40 m (66 to 132 ft) isolation strip. Areas of 2 ha (5 acres) or less will usually be seeded in from the surrounding stand. Areas treated for mistletoe should be checked in 10 years to make sure the disease is under control.

Areas managed using these mistletoe control strategies may eventually be free of dwarf mistletoe. At the minimum, the incidence of infection will be reduced and the age at which the trees become infected will increase. This will ultimately reduce the impact of dwarf mistletoe and increase the productivity of these

stands. Control measures applied to infection pockets on good sites can result in a favorable cost-benefit ratio by protecting large areas of healthy spruce.

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